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Farm Ponds

in New York

Carl S. Winkelblech

A New Format

During the past decade or more, much has been written about readability and readership. The Extension Service has tried to keep abreast of any or all methods that would help readers of our publications.

Recently, the reading laboratory of a large publishing company tested various formats for "speed reading" on the theory "that executives are swamped with 'must' reading and need publications that give main facts, details when they're important." They came up with the idea of "using headlines as leads in articles rather than as summary of contents" and put important points in bold-face type. The reader gets the story outline by reading the heads and bold face only. In their words—"We're trying to give you the maximum payoff for your reading time." They have tried this in several issues of one of their publications. Other publishers, too, are toying with the idea.

We feel the idea has real merit, so in this bulletin (949) we have put the important facts in bold-face type to help the reader to find quickly the information he needs. More details follow if he wants or needs to read further. Not all manuscripts lend themselves to this kind of presentation, but we hope readers may find it helpful in this bulletin.

The Editor

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Farm Ponds
In New York

Carl S. Winkelblech*

With careful planning and good construction, a pond is often the most valuable acre on the farm.

This publication is written to guide land owners in the selection of pond sites. It explains some of the principles of design and construction that are satisfactory and economical under most conditions on small watersheds.

The services of a qualified engineer should be obtained where special construction problems are anticipated, or where failures of the pond could result in damage to life or property.

Technical help is available through Soil Conservation Districts and County Agricultural Agents, as well as through private engineers and contractors.

Legal Responsibility

Section 948 of the Conservation Law was enacted in the public interest to reduce the posibility of washouts and flooding that might result from faulty dam construction. This law states, in effect, that prior approval of plans must be obtained from the New York State Department of Public Works (Form E-61) when one or more of the following conditions exist.

1. **The dam will impound more than one million gallons.**
2. **The drainage area exceeds one square mile (640 acres).**
3. **The dam will be more than 10 feet in height above the natural bed of the stream.**

This law was amended in 1954 to permit the construction of "farm ponds" under the supervision of a licensed professional engineer or

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an engineer employed by an agency cooperating with any soil conservation district provided notice is given to the State Superintendent of Public Works prior to such construction when:

1. **The height of earth embankment for water impoundment does not exceed 15 feet measured from the top of the dike to the lowest point in the reservoir area.**
2. **The capacity does not exceed one and one-half million (1,500,000) gallons as measured at the highest point of the spillway.**
3. **The drainage area does not exceed two hundred acres.**
4. **The maximum slope of the vegetated spillway is 1 per cent.**

Note that in the original law, plans must be approved, as stated, under certain conditions; in the amended law, only a notice is given to the State Superintendent of Public Works when the work is supervised by a licensed professional engineer or an engineer employed by an agency cooperating with any soil conservation district.

Regardless of the provisions set forth in the law, **the land owner has additional personal responsibility.** A farm pond might be considered an unnatural hazard and, as such, **the owner should take reasonable precautions to warn trespassers of possible danger.** Fences built to enclose the pond area and "No Trespassing" signs are usually considered reasonable precautions. As further protection against possible damage claims, some owners carry liability insurance.

Two Types of Ponds

In general, ponds are grouped according to the location of the reservoir; a dam impounds water above the natural ground surface; a dugout, or excavated, reservoir impounds water below the natural ground level. In practice, **most small ponds combine some features of each type to produce the most economical structure.** In this bulletin each type is considered separately.

A dam impounds more water per cubic yard of earth moved than a dugout or excavated reservoir. It must be carefully constructed to prevent leakage and washouts, because the water mass is in a potentially dangerous position above ground. **Its location is limited to areas with sloping terrain where the shore line is well defined and moderately steep.**

A dugout, or excavated, reservoir is the simplest to construct and the only type that can be built economically in flat terrain. Water-storage capacity is directly proportional to the amount of excavation

and, therefore, the size is limited by the type of excavating equipment and the amount of money a land owner is willing to invest. The dug-out pond is popular because it is simple to build, compact, relatively safe from flood damage, and requires little maintenance. Its chief disadvantages are the higher cost per gallon of storage and the difficulty of getting water from it.

Location

The usefulness of a pond depends on its location, size, depth, source of water supply, and construction features that may be added at the time of construction.

As a source of water for fire protection, the pond should be within 500 feet of the farthest protected building and adjacent to an all-weather road. It should have a capacity of at least 100,000 gallons and a minimum depth of 8 feet within 15 feet of the roadway. A brine barrel, oil-soaked plug, or a suitable hydrant should be installed so that water can be removed from the pond when it is covered with ice.

A dry or pressure type of hydrant equipped with the standard 4½ inch steamer connection greatly increases the convenience and use-

Figure 1. A dry hydrant and access to a good road make this pond valuable for fire protection.

fulness of a pond for fire protection. A 4-inch pipe may be extended through the dam with a screen and gravel filter on the inlet end. With the hydrant at a convenient place along the road or near the buildings, water should be readily available at all times. On a dry hydrant, the suction lift of water should be about 5 feet and the maximum lift cannot exceed 20 feet. A standard pressure-type hydrant can be used when the pond is at a higher level than the hydrant. It should be constructed with a gravel drain at the base of the hydrant to prevent freezing.

As a source of water for livestock a pond should be convenient to pasture or buildings. Priority should be given to sites that permit gravity flow of water to stock tanks or buildings, since hoof infections and water contamination are possible where livestock have direct access to the pond.

Total water requirements for a dairy herd amount to from 35 to 50 gallons per cow per day; other livestock use proportionately less. Total needs for a season can be calculated.

A pond, supplied entirely by surface water, should be built to hold at least six times the anticipated seasonal needs of the livestock. This additional capacity should be enough to take care of evaporation and normal leakage and still provide a deep pool of fresh water reasonably free of weeds and algae for livestock use. A pond is not considered a satisfactory water supply for human consumption or for use in the milk house without chlorination, according to public health authorities.

Figure 2. On a pressure or dry type of hydrant, a large screen area is needed in the pond to keep friction losses low.

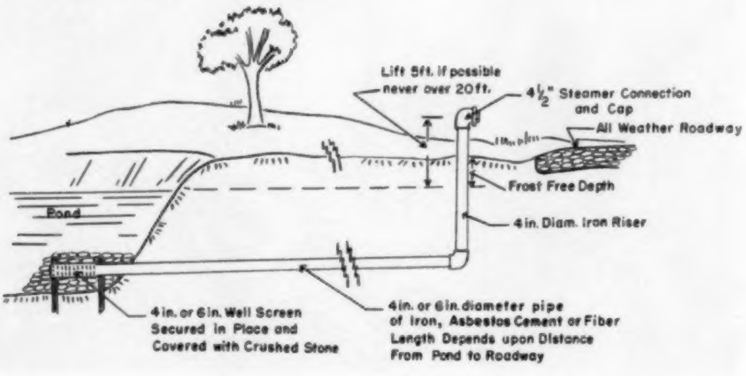
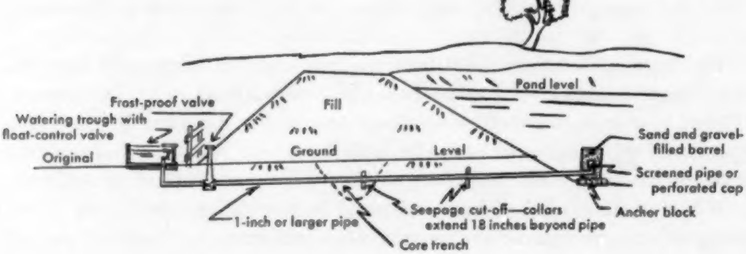


Figure 3. A water tank outside the pond assures better herd health and a more sanitary pond. A float controls the water level in the tank.

As a source of spray water, **ponds should be where travel distance with the sprayer can be kept to a minimum.** Some large orchardists prefer several smaller ponds to one large one for this reason. It is general practice to design **spray-water ponds to hold about three times the anticipated seasonal needs. A minimum depth of 8 or 10**

Figure 4. Close attention to construction details insure a good water supply for livestock outside of the pond area.



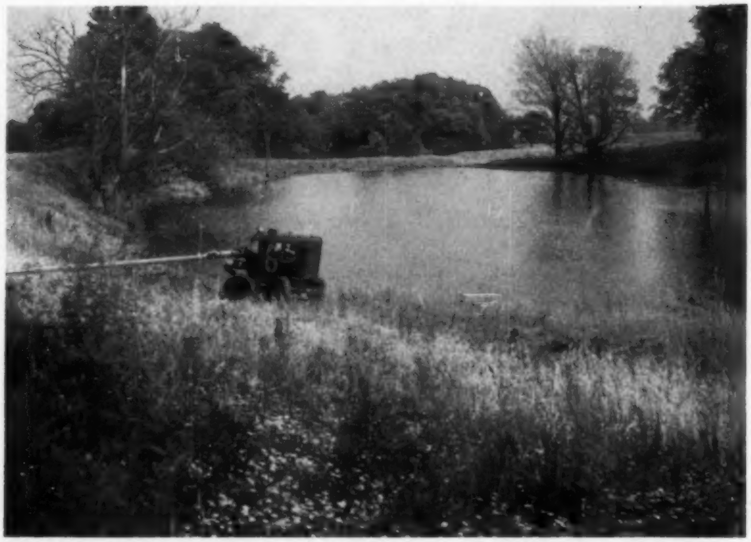


Figure 5. Irrigation ponds should be planned as a part of the entire irrigation system by experienced engineers.

feet is desired to keep evaporation losses low and to help reduce weed problems. Not all the water can be recovered from the pond bottom because of the danger of silt entering the delicate pump and sprayer mechanism.

Ponds to be used for irrigation deserve special consideration. From 80,000 to 300,000 gallons of water are needed for each acre to be irrigated, and this quantity, plus the normal pond losses, can seldom be obtained economically from a farm pond unless the topography, watershed, and soil conditions are very favorable, or unless the area to be irrigated is rather small. Ponds for irrigation should be planned by an experienced engineer so that the water supply and the pumping and distribution system can be designed as a functional unit.

Ponds to be used as wildlife areas are built to encourage cattails, duckweed, wildrice, and many other plants adapted to shallow water. These plants in turn, furnish food and cover for certain desirable species of wildlife such as ducks and muskrats. Marsh areas are also a haven for song birds, pheasant, rabbit, deer, and other game animals.

A marsh differs from the usual pond in that water should be 3 feet deep or less over most of its surface. Consequently, the site should

Figure 6. Wildlife ponds should be shallow to encourage the growth of food and cover for game animals and birds.

be in rather flat or gently rolling terrain, on wet or swampy lands not generally suited to more intensive agricultural uses.

The New York State Conservation Department may lease areas and pay the cost of development where the land owner is willing to cooperate and the site meets certain requirements. The length of the lease to the State can be reduced if the landowner contributes to the cost of improvement. Specific details can be obtained from the respective district game managers.

General purpose ponds combine two or more uses into a single water area. If particular attention is given to selecting the site and to shaping and grading the area around the pond, it may be used for recreational purposes as well as for livestock, fire protection, and other farm uses. It is obvious that the pond should be large enough to take care of all normal uses with a generous reserve supply for recreational purposes.

In New York State, general-purpose ponds should be built so that **at least one-third of the pond area is 8 feet or more deep.** If cattail and other aquatic vegetation are to be discouraged from growing along the edges, the shore line should be deepened abruptly to 3 feet or more. These construction principles will not eliminate the need to

Figure 7. A pond with many uses increases the value of the farm and adds to the pleasure of rural living.

control weeds but should make control easier. A surface area of one-fourth to 1 acre and a storage capacity of 400,000 gallons to one million gallons is usually large enough for the ordinary farm needs. A neat, well-landscaped pond that serves many uses is an investment that adds to the value of the property.

A Dam

Site

The ideal location for a dam seldom exists in nature, but there are a number of points to consider when selecting the site that may influence construction costs and future maintenance problems. **A well-defined draw or depression, with a slope between 4 and 8 feet per 100 is desirable.** On steeper slopes, increasingly higher dams are needed to impound the same amount of water and safe spillways become more difficult to build. A depression with from 1 to 4 feet of slope per 100 is usually suited to a combination type of pond where the reservoir capacity is gained by a dam on the lower side with the excavated soil removed from the flooded area. In very flat terrain, the water area must be created entirely by excavation below the natural ground level. (Dugout, or excavated, ponds are discussed on pages 22 to 27.)

A narrow drainageway reduces the amount of material needed to build the dam, but usually the flooded area behind it is small.

Gradual slopes, both in the drainageway and on each side, with a good sod cover, are preferred to a drainageway that shows scars of

severe erosion and flooding. Debris-laden cross fences and raw gullies are good indicators that high flood waters, silt, and erosion could shorten the life of a pond.

A small watershed

If there is any one most important consideration in building a farm pond, it is the size and condition of the watershed or drainage area. A constant flowing stream is not necessary as a source of water. In fact, it usually is undesirable since it may increase the cost of construction and complicate future management and maintenance.

Under most soil and slope conditions in New York, a drainage area of 5 acres contributes enough water to supply a pond that holds one million gallons. If the pond is fed by a spring or seepage area above the shore line, little or no additional surface drainage is necessary.

Excess water that passes through the spillway and trickle tube serves no useful purpose to the pond. Spillways and other protective features of the pond must be designed to carry flood waters many times greater than the normal or low flow, and the cost of these features of the pond are directly related to the size of the drainage area. Watersheds showing signs of severe erosion or that are contaminated by barnyard runoff or sewer outlets should be avoided unless the erosion can be eliminated and the sources of contamination diverted around the pond.

Figure 8. A draw, with gradual sloping topography and a small watershed, is ideal for a small farm pond.

A heavy subsoil

The success of a pond may depend upon the depth and texture of the subsoil.

A good subsoil for pond construction should be deep to bed rock, at least 2 feet deeper than the proposed bottom of the pond. It should be reasonably free of large stones, and contain a high proportion of clay. A moist soil that contains the right amount of clay feels somewhat greasy to the touch and feathers out into a flat disk when compressed between the thumb and the forefinger. A thin film of dry soil feels like talcum powder when rubbed between the fingers. A powdery residue adheres to the skin crevices. A more reliable test can be made, however, when the soil is moist. Some silt and sand may be present in the material but at least one-third of it should be clay. Another way to determine the amount of clay is to add a pint of water to a pint of the representative soil in a glass jar, mix thoroughly by shaking, then allow the soil to settle. Coarse sand settles immediately, fine sand within a few minutes, and silt and clay in two to twenty-four hours. The thickness of the layers thus formed are a guide to the various particle sizes and the proportion of each in the mixture.

A soil auger, post-hole auger, or shovel may be used to sample the subsoil. Enough samples should be taken in the foundation area to make sure a good footing for the fill material exists, and to detect shallow rock ledges, sand layers or subsurface drains that could cause water to leak underneath the completed dam.

Abrupt slope changes, sink holes, and stony ledges, are signs of rock strata near the surface and call for a close investigation. It is very difficult to prevent leakage along the top of rock layers or through fissures in them.

The natural vegetation on the site and the shape of the surrounding area may give some clues to the subsoil characteristics. Plants, such as alfalfa, black locust or sumac, growing in the area, indicate a well-drained soil which is usually not adapted to pond construction. Sedges and cattails are usually associated with a high water table, heavy soils, or a seepage area. These conditions are favorable for a pond.

A survey of the site

It is important to know the correct relationship between the topography of the site and the completed dam. This can be obtained by a plan developed from a survey of the area. **A survey should provide**

Figure 9. A survey is needed to determine the size of pond and the most economical location for all structures.

enough information to determine the drainage area; the location of the shore line; the depth of water at critical points; the location and height of the dam; and the size and location of the spillway, trickle tube, and water pipes.

The Spillway and Trickle Tube

Inadequate spillways are a common cause of pond failure. The spillway acts as a safety valve that protects the dam from overtopping during heavy runoff and, as such, it must be designed to carry many times the normal flow of water. **The most economical spillway for a pond with less than 50 acres of drainage area is a wide, flat channel, built at either end of the dam in undisturbed soil.** The flat channel should be well sodded and shaped to return flood waters to the original drainageway without causing erosion. It should have a uniform and gradual slope. Excavation will usually be necessary to shape a spillway but it should be kept to a minimum. A grass cover can be re-established more easily if the top soil is not entirely removed. Low-growing grasses, such as creeping fescue or Kentucky blue, are considered more desirable for spillway protection than legumes because they offer less resistance to the flow of water. In most instances a trickle tube should be provided as additional protection for the spillway.

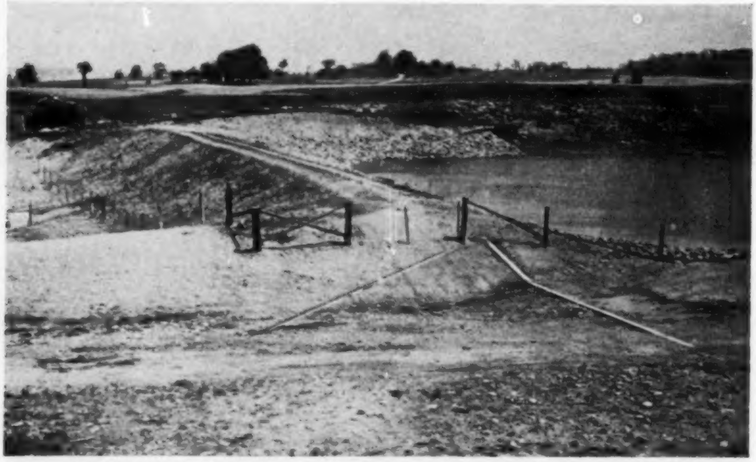
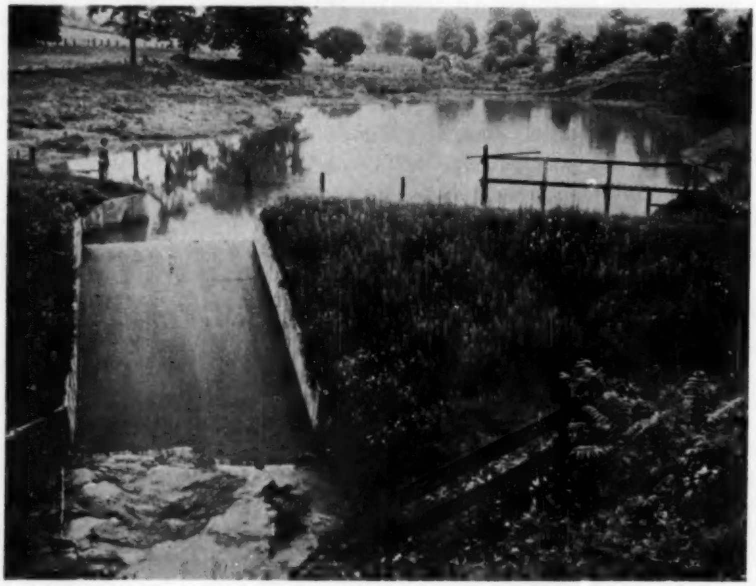


Figure 10. This wide, flat spillway is designed to return flood waters to the natural drainage channel without danger of erosion or dike failure.

Figure 11. On large watersheds, concrete or masonry spillways may cost several times more than the cost for moving the earth.



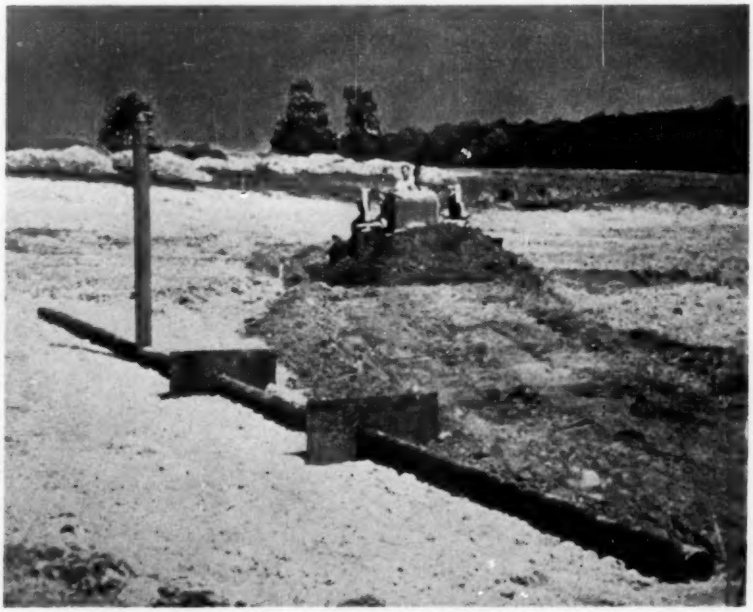
The trickle tube

In combination, the trickle tube and sod spillway are usually the most economical way to handle overflow from farm ponds on small water sheds. They are easier to build and less costly than overflow structures of reinforced concrete or masonry.

The trickle tube has one basic purpose, that is, to keep the sod spillway dry except in time of high runoff. The upper, or inlet, end of the trickle tube is on the upstream side of the dam at a level from 6 to 12 inches below the bottom of the sod spillway and from 30 to 36 inches below the top of the dam. The outlet, or discharge, end extends through the dam to the level of the natural drainage way. This end should be protected against erosion by an apron of heavy stones. The trickle tube carries the low flow from springs or seepage areas, while the sod spillway, located at the higher level, is dry except during high runoff and, therefore, can support a dense grass cover.

A trickle tube frequently represents about one-third of the total cost of an ordinary farm pond, and it can be a source of leakage if not properly built. Under certain conditions, the trickle tube may be

Figure 12. The trickle tube, with vertical riser and cut-off collars, is installed in the base of the dam before the dike is built.



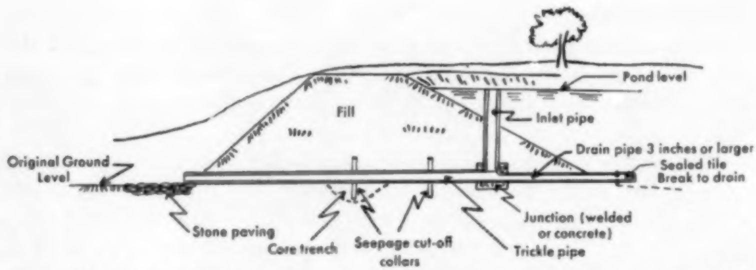


Figure 13. A dam with the trickle tube in the lowest part of the draw. A smaller pipe extends into the pond to serve as a drain.

eliminated without affecting the safety of the dam. The sod spillway may be used alone where the drainage area is small and surface water is the only source of supply. The character of the vegetation in the natural drainageway can also be used as a guide in determining the need for a trickle tube. If the drainageway is well sodded with the same kind of plants that are found on the adjacent slopes, and if there is no well-defined channel, it is reasonably safe to assume that a well-managed sod spillway may be used alone. If, however, there is any doubt, the trickle tube should be included.

The excavation for the trickle tube can be made after the site has been cleared of topsoil and vegetation. The trench should be wide enough to permit adequate tamping around the pipe.

A trickle tube can be in one of several places. If a drain is to be included as a part of the pond, the trickle tube may be placed

Figure 14. A heavy stone or concrete headwall and apron protect the discharge end of the trickle tube against erosion.

through the lowest level of the base of the dam. A 3-inch, or larger, pipe may extend through the up-stream face of the dam from the intersection of the riser pipe and trickle tube. This extension is equipped with a manually controlled valve or flap gate or is sealed with one section of vitrified tile that may be broken to drain the pond. This trickle tube and drain arrangement should be used where flowing water might otherwise interfere with dam construction. The drain can be left open until the dam is completed.

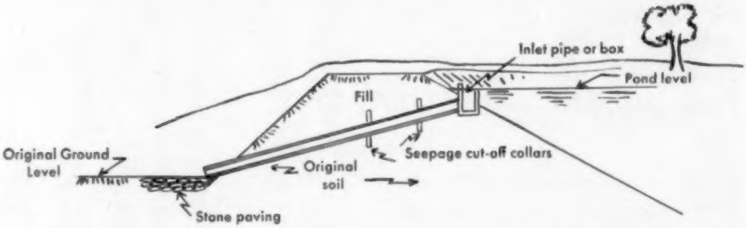


Figure 15. Where a drain is not needed, a short concrete riser instead of a steel pipe riser may be placed on the side of a dam.

If a drain is not considered necessary, the trickle tube may be on a side of the pond with a relatively short riser or inlet. This type usually requires a greater length of pipe to reach the original drainageway but it is easier to build and seal against leakage.

For maximum flow through the trickle tube, the vertical riser or inlet should have at least double the throat area of the trickle tube as indicated in table 1.

Even though care is used in tamping the backfill, **there may be some leakage along the outside of any pipes laid through the dam unless seepage cut-off collars are built around the pipe.** These may be of sheet metal, welded directly to the pipe or of poured concrete walls from 6 to 8 inches thick. On a dam up to 15 feet high, two collars, one about the midpoint of the dam and another 25 feet upstream on the pipe, should be satisfactory. **A water pipe for livestock, if it is to be included in the pond, can be placed in the same trench as the trickle tube and a common seepage cut-off collar can be used for both pipes.** The stock pipe will, however, need to be below frost line, outside the dam.

Size of trickle tube and spillway

If the top of the dam is at least 2 feet higher than the bottom of the sod spillway, the relationship between drainage area, trickle tube, and

spillway sizes given in table 1 should be satisfactory for most conditions.

Table 1. Relation of drainage area to trickle tube and spillway

Drainage area	Diameter of trickle tube	Diameter of inlet or vertical riser	Width of sod spillway
Acres	*Inches*	*Inches*	*Feet*
Up to 5	4*	6*	8
5 to 10	6	8	12
10 to 20	6	8	18
20 to 30	8	12	24
30 to 40	8	12	30
40 to 50	8	12	36

*Ponds with less than 5 acres of drainage area do not require a trickle tube unless they are fed by a spring or seepage area in addition to surface water.

The Earth-fill Dam

The final location of the dam is related to other elements of the pond, but preference should be given to a site with deep, heavy soil where the least amount of fill impounds the greatest amount of water.

Figure 16. Topsoil and vegetation should be removed from the dam and pond area before construction begins. The topsoil can be used later on the back slope and top of the dam.

Figure 17. A core trench exposes stone drains, gravel lenses, and other sources of leakage below the base of the dam.

The site, particularly the dam foundation, should be cleared of all vegetation and dead organic material, otherwise a seepage plane might develop between the new fill and the original ground level. Topsoil and sod may be stock-piled and later spread on the completed back slope and top of the dam, but never should topsoil, trees, brush, stumps and stone piles be included in the dam or within the pond area.

A core-trench should be dug in about the center of the foundation, extending from one end of the dam to the other. This excavation is necessary to expose sources of leakage, such as tile or stone drains, sand or gravel lenses, and rock layers. The shape of this trench will depend upon the equipment used, but its depth should be at least 3 feet and more if necessary to reach impervious clay. Any porous areas that are exposed in the core excavation should be removed. The entire core trench should then be refilled with clay and well tamped. This step will also help to secure a better bond between the fill material and the natural soil.

The base width of the dam will vary according to the height of fill at all points across the drainageway. Under most soil conditions, a

base width equal to the top width plus five times the height is satisfactory to withstand the water pressure, retard leakage, and permit the establishment of grass on the slopes. The upstream slope of the dam is usually built somewhat flatter than the down-stream slope, with a rise of about 1 foot in every 3 feet of horizontal run. This slope is about as steep as a good bulldozer can climb with a blade full of dirt. The full base width should be well marked before construction begins, since it is difficult to widen the base after the fill is started and get uniform compaction of the entire mass.

Top width of the dam should be wide enough to accommodate an occasional farm tool that might be needed for maintenance. In practice it is difficult to build the top much narrower than the construction equipment. A top width of 10 feet is satisfactory except where the dam must be used as a roadway, then it should be at least 14 feet wide. A wide top increases the amount of fill material required, but it is good protection against wave erosion and burrowing animals that could cause failure.

Fill material should be obtained where it will need to be moved the shortest distance. It is generally more economical to take it from the pond area, thereby increasing depth and storage capacity. Where a high water table exists or where the pond bottom should not be disturbed, fill may be transported from a borrow pit having satisfactory soil qualities but construction costs will be considerably higher.

Figure 18. A wide top reduces the danger of erosion and permits easier maintenance.

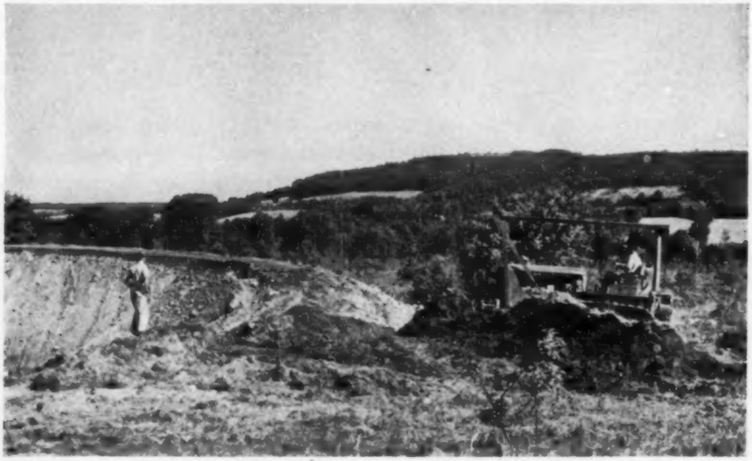


Table 2. Cubic yards of fill per linear foot of length in earth dams with a 3 to 1 slope on the upstream face and a 2 to 1 slope on the downstream face and top widths as indicated.

Fill height	Amount of earth in fills having a top width of			
	8 feet	*10 feet*	*12 feet*	*14 feet*
Feet	*Cubic yards*			
1	0.4	0.5	0.5	0.6
2	1.0	1.1	1.3	1.4
3	1.7	1.9	2.2	2.4
4	2.7	3.0	3.3	3.6
5	3.8	4.2	4.5	4.9
6	5.1	5.6	6.0	6.4
7	6.6	7.1	7.7	8.2
8	8.3	8.9	9.5	10.1
9	10.2	10.8	11.5	12.2
10	12.2	13.0	13.7	14.4
11	14.5	15.3	16.1	16.9
12	16.9	17.8	18.7	19.6
13	19.5	20.5	21.4	22.4
14	22.3	23.3	24.4	25.4
15	25.3	26.4	27.5	28.6

Uniform compaction is needed through the entire height of fill, from the core trench to the top. Fill should be spread in layers rather than dumped in piles. Each layer should be well packed by the bulldozer or excavating equipment. In soils of doubtful water-holding ability, constant and more thorough packing should be done on each layer with a sheep's foot roller or other heavy tool. The soil should contain a medium amount of moisture—just enough to make it slightly adhesive and pliable. If the soil is powdery dry, it is safer to delay construction until more favorable moisture conditions exist. Wetting of the fill is seldom practical unless large quantities of water are available at the site.

The amount of settlement of the completed dam is greater as soil texture, moisture, and degree of compaction deviate from ideal conditions. In practice, the height of earth dams is usually increased about 10 per cent to allow for this settling, since the final height of settled fill must be maintained for the safety of the pond.

Stones do not interfere with the water-holding ability of a dam if the quantity is limited and they are well distributed in the downstream half of the dam. Avoid dumping stones in piles or windrows that could act as a drain through the dam.

Frozen soil cannot be compacted properly and should never be placed in the dam. If a layer of material freezes during a delay in construction, it should be removed or allowed to thaw completely

Figure 19. The dike is begun with a wide base and each layer of fill is compacted.

before construction is resumed. Winter construction is not generally recommended because frequent delays and excessively wet soil conditions, as well as frost, are likely to increase costs. There is also no opportunity to establish sod in the spillway before spring runoff occurs.

A Dugout, or Excavated, Pond

Nearly half the farm reservoirs that have been built in New York are the dugout, or excavated, type where the entire water storage is below the natural ground level. It is the only possible choice in areas of flat terrain, but even in sloping areas conditions frequently exist where a dugout may be more economical. Many requirements that are necessary for the success of a dam also apply to sub-surface reservoirs.

The Site

Soil

An impervious soil at least 2 feet deeper than the anticipated pond depth is essential, except in areas where a permanently high water table can be found within several feet of the surface. In this situation, the earth excavated is simply replaced by water which seeks the same level in the pond as in the surrounding soil. Here soil texture is

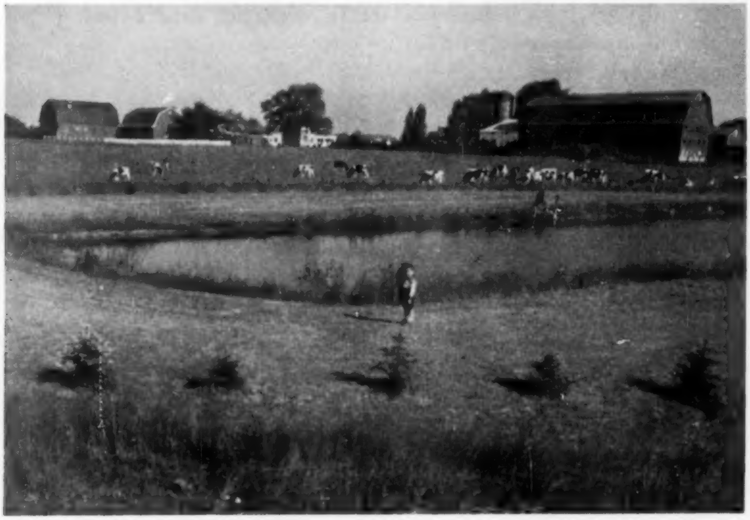
of minor importance. In soils composed largely of fine sand, however, it may be difficult to stabilize the pond banks. The saturated sand tends to flow into the pond thereby decreasing its effective depth. Flatter sides and end slopes should help to control this condition, but it may be necessary to reclean the pond bottom after several years of use after the slopes have reached a natural angle of repose.

Generally, dugout ponds depend upon surface water as a source of supply, in which case the same soil requirements are needed as in a dam. Borings or samples of soil should be taken to determine the water-holding ability. Soil samples should contain at least 40 per cent of clay—a somewhat higher proportion than in a dam—because there is no practical way to compact the dug out pond sides beyond that which the soil contains in its natural condition.

A test hole may save considerable money and disappointment where there is some doubt as to the water-holding ability of the soil. The test hole should be dug to the full depth of the proposed pond but only large enough in area to maintain stabilized edges. The water level fluctuation in the test hole, from early spring to late fall, will correspond closely to that of a larger pond in the same location.

The cost of a dugout pond can be greatly influenced by the location of the spoil distribution area. The site should be one where the spoil

Figure 20. In a dugout pond, all the water is stored below natural ground level.



can be spread on at least three sides of the pond without interfering with surface drainage.

The watershed

The dugout pond is similar to the dam in that it can become a repository for silt, debris, and contamination. **In situations where flood waters shorten the life of a pond, one can build the dugout to the side of a main drainageway or divert the main stream around the pond.** A wide choice of locations is usually possible for the dugout without affecting the cost of construction, so there is seldom any justification for building it in the path of a large watershed.

A by-pass pond is supplied by a controlled flow of water from a nearby stream. A tile or pipe line is laid from a point in the stream that is at the same level as the desired water surface of the pond. The pipe acts both as an inlet and an outlet, maintaining a fairly constant water level in the pond without carrying any of the floodwaters. A simple survey should be made to determine the correct relationship between pond-water level, inlet location, and the grade to which the pipe is to be laid. This arrangement is most effective where stream flow is continuous through the year.

Excavating Equipment

Excavation is the principal work required in dugout pond construction and, therefore, **it is important to select the kind of equipment that will operate most efficiently under various conditions.** Soil borings prior to construction will help to make this decision.

Experience indicates that a medium to large sized bulldozer is a satisfactory tool to use on ponds with a capacity up to about one million gallons. The bulldozer can be used to level the spoil material as it is removed from the pond, but costs increase rapidly if the distance of travel from the pond to the leveling area exceeds 200 feet. A bulldozer requires solid footing to operate efficiently, consequently it can seldom be used during wet weather or on a pond site with a high water table.

A backhoe or dragline must be used to excavate ponds where wet conditions prevail. The power unit for these machines can be on the bank or ground surface, while the attached bucket can be controlled, within limits, to excavate the pond. An efficient dugout pond layout should be based on the operating limits of the equipment, otherwise it may be necessary to move a part of the excavation several times.

The most common backhoes can excavate an area from 18 to 24

Figure 21. A by-pass pond is supplied with water from a large drainage area through an inlet pipe. Flood waters are thereby excluded from the pond.

Figure 22. To operate efficiently, a bulldozer needs solid footing.

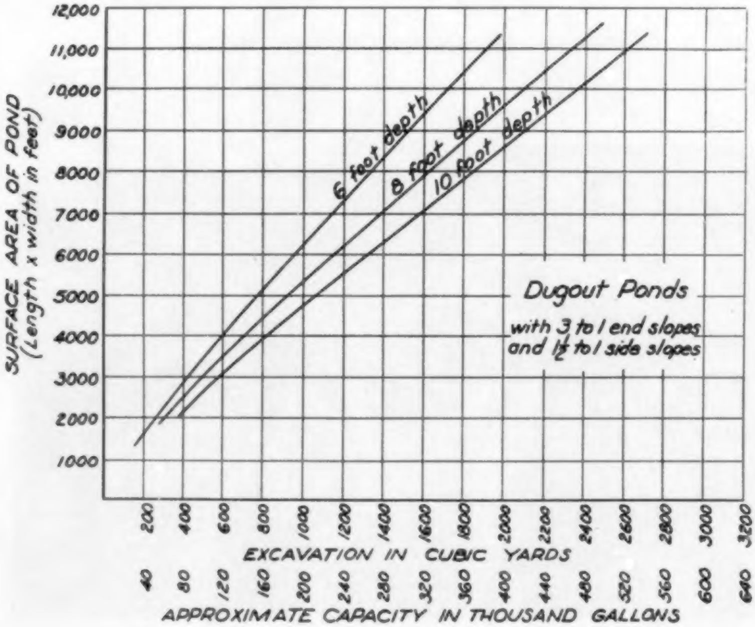
feet wide and up to 12 feet deep, from the same location. The maximum top width of a pond dug with this machine would then be limited to about 36 to 40 feet, if earth can be cast to both sides of the pond. There is no mechanical limit to the length of pond dug with a backhoe.

A dragline bucket is attached to the power unit through a boom and cable arrangement. It has the advantage of a much longer reach than a backhoe; but since control of the bucket is through a flexible cable, **it cannot operate efficiently under hard, stony conditions.** A dragline can excavate ponds up to 60 feet wide and 12 feet deep where spoil can be distributed on both sides.

Since neither of these machines is suitable for leveling, a bulldozer will be needed to perform this additional operation, and cost will be increased accordingly.

Capacity of Dugout Ponds

The capacity of a dugout pond is directly related to the amount of excavation. Each cubic yard of earth removed below the planned water level will be replaced by 202 gallons of water. Since evaporation



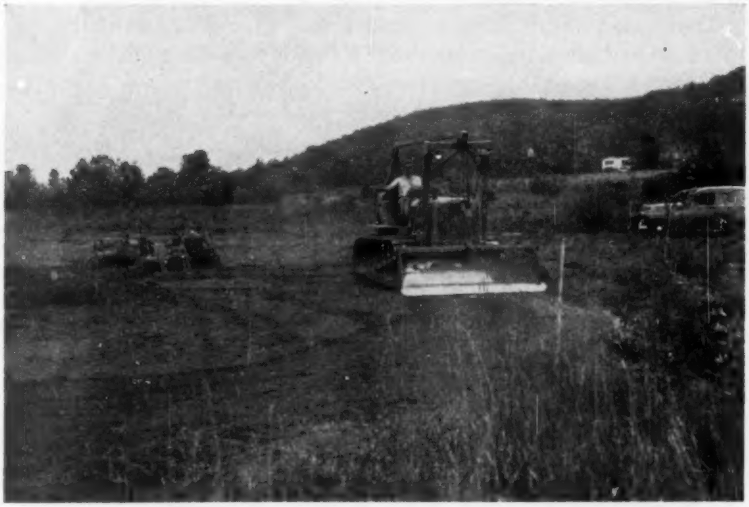
is related to water temperature and surface area, it is good practice to make the pond as deep as possible and limit the surface accordingly. The chart on page 26 shows the relationship between surface area, depth, excavation, and storage capacity of ponds having $1\frac{1}{2}$ to 1 side slopes and 3 to 1 end slopes and average depth of 6, 8, and 10 feet. Surface area can be obtained by multiplying the width times the desired length.

Final Grading and Seeding

The finishing touches—a few extra passes with the bulldozer or spring-tooth harrow—may be all that are needed to transform an unsightly hole into an attractive pond area. All raw earth should be graded to a neat finish.

Shallow areas near the shore line should be deepened to reduce weed-control problems. Disturbed soil outside the normal water level should be prepared for reseeding as soon as possible after earth moving is completed. A good mixed fertilizer should be broadcast at a rate of about 500 pounds per acre and worked into the surface 3 inches. Lime at the rate of 2 tons per acre is needed if the soil is acid. A seed mixture containing bluegrass, creeping red fescue, and rye grass should be broadcast at a rate of 30 pounds or more per acre. The seeding should then be covered with a protective layer of mulch.

Figure 23. A neat finished grade adds to the attractiveness of the pond and simplifies future maintenance.



A new blanket of grass is essential to improve appearance and prevent erosion, especially in the spillway.

Estimating Construction Costs

Since ponds cannot be produced on an assembly-line basis, under controlled conditions, exact cost estimates cannot be made that would apply over wide areas. Usually, however, **local contractors can estimate costs if complete plans are available and soil conditions at the time of construction are known.** As a guide, however, **the average farm pond covering about one-half acre of surface area and impounding about one-half million gallons of water may cost from $400 to $600.**

Earth moving with a bulldozer may range from 20 to 40 cents per cubic yard. The 20 cent figure applies where an efficient operator can take advantage of a short "haul" with ideal soil conditions. Forty cents per yard applies where wet soil, stoniness, greater earth-moving distance, or lower operating efficiencies prevail. Earth-moving costs may exceed $1 a yard if fill material must be transported to the site from a borrow pit.

A high water table or unstable footing may make it necessary to use a dragline or backhoe for the pond excavation. The cost under these conditions may range from 40 to 60 cents per cubic yard, including leveling and grading the excavated material after it becomes dry enough to use a bulldozer or scraper.

Trickle tubes and other structures vary in cost according to size, material, and labor for installation. A trickle tube for a ten-acre drainage area will probably cost from $75 to $150, with costs increasing proportionately as the drainage area increases.

Maintaining the Pond

The amount of maintenance a pond requires depends to a great extent on how it was built. Weeds and algae are less likely to grow where the pond bottom was well cleared at the time of construction and where most of the water is more than 4 feet deep. Older ponds, however, require weed control regardless of depth.[1]

Most persons like to landscape the area around a pond, but **trees and shrubs should be limited to an area behind the shore line and not planted on the dam.** Woody plants on the dam furnish an attractive environment for burrowing animals, such as woodchucks and

[1]Cornell Extension Bulletin 910, *Controlling Weeds and Algae in Farm Ponds,* has helpful information.

muskrats. They also interfere with mowing and other maintenance operations. Dead roots may also cause a zone of leakage within the dam.

As a general practice, **livestock should be fenced out of a pond** because they tend to contaminate the water, trample the shore line, and destroy the sod spillway. If it is not practical to install a gravity-fed water tank for stock, a fence might be built to give the animals limited access to a part of the pond away from important structural features. It is usually difficult to mow the odd-shaped areas between the fence and the water edge, and limited grazing in the dry season is possible. Livestock should be removed, however, as soon as grass is consumed and before there is any damage to the shore line and spillway.

Burrowing animals, especially muskrats, can damage the dam by reducing its height and creating holes through which water may leak. Muskrats should be removed when their presence is detected in the dam. Cat-tails are a favorite food of muskrats, but eliminating this food supply may offer some control.

The watershed above the pond should be protected against erosion because silt can reduce the capacity in a short time and recleaning is usually more costly than the original excavation.

Figure 24. Shallow pond edges increase the control problem of cattail and other aquatic plants. The shoreline here should be deepened to ease maintenance.

Cloudy-pond Treatment

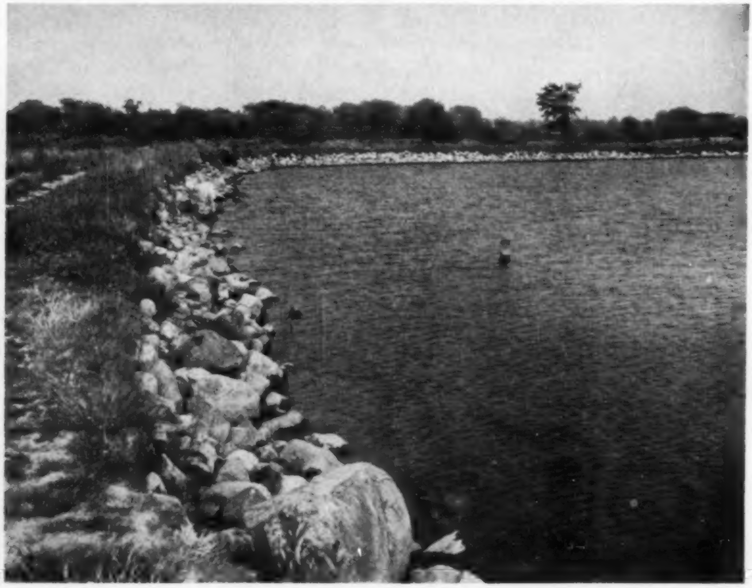
In some ponds, water does not clear up after construction or after heavy rains. **The cloudy condition is usually caused by fine clay particles that remain in suspension.** If soils within the watershed are acid, an application of about 1000 pounds of lime per surface acre of water may flocculate the clay particles and cause them to settle. Gypsum has also been used successfully for cloudy conditions when applied at the rate of 1 to 1½ pounds per 1000 gallons of water in the pond.

Preventing Shore Erosion

Shore erosion may be a serious problem on newly built ponds where sod has not become established, especially where the dam faces the prevailing wind.

If large quantities of flat stones are available at low cost, the face of the dam may be riprapped about 2 feet above and below the normal water level. This stone lining will not only reduce wind erosion but also reduce weed control problems and discourage the burrowing of muskrats. **Where stones are not available, poles may be anchored at**

Figure 25. Wave erosion can be prevented on the inside face of the dam with a stone paving or with poles anchored near water level.



normal water level to break the force of the waves. This method is temporary but should last until the shore line is protected by a good sod.

Stopping Pond Leaks

In some areas, a pond may be the only possible solution to a critical water-supply problem. Under such conditions, it may be desirable to build a pond even though the water-holding ability of the soil is doubtful. **Usually a leaking pond improves in water-holding ability in three or four years,** as clay and fine silt particles are gradually drawn into the porous areas.

Another method that has been successful on some soils is to confine livestock in the pond area. The constant treading under sharp hoofs compacts the wetted surface of the pond more completely than the usual construction machinery.

Commercial sealing materials that have a high colloidal content and expand on contact with water are available. They are most effective when mixed with a layer of soil within the pond. These commercial materials can be justified economically to treat localized seepage spots but are expensive to use on the entire wetted pond area.

Managing the Pond for Fish Production

The value of a pond is increased by stocking and managing it for fish production. The same construction principles that are recommended for other pond uses apply also to fish production. **A depth of at least 8 feet over one-fourth of the pond should provide a cool place for fish during high summer temperatures as well as protection from asphyxiation because of thick ice in winter.** A shore line with a minimum of shallow water, simplifies the problem of controlling weeds and of maintaining a balanced fish population. A small watershed reduces the possibilities of flood-flow damage and the amount of fertilizer washed out of the pond.

Studies are being conducted by the Department of Conservation on the management of bass-bluegill, trout, and minnow ponds to refine the recommendations for New York State conditions. Results and current recommendations will be available through County Agricultural Agents. Until new information is brought to light, the recommendations developed in more southerly latitudes will generally be followed.

Ponds with a high water temperature in summer are stocked with fingerlings at the rate of 1000 blue-gill sunfish and 100 large-mouth bass per surface acre of water. Spring-fed ponds or those with a

maximum summer water temperature at the surface of 80° F. and never more than 85° F., with a maximum depth of at least 8 feet and two-thirds of the area 6 feet deep or more, may be stocked with trout at a rate of about 300 per surface acre of water.[2]

Adding other varieties to each of these recommendations or increasing the number of fingerlings above the suggested rate may encourage management troubles, such as an unbalanced fish population and stunted growth. A pond is capable of producing a limited number of pounds of fish each year. This total weight may be made up of thousands of small fish or a smaller number of pan-size fish.

Like any other crop, high fertility increases the yield of fish. A commercial fertilizer, such as 10-10-10, should be applied to the surface of the water in sufficient quantity and frequency to maintain a brownish green water color. The color is attributed to an increased amount of microscopic plant and animal life in the water which is used as food by the blue-gill sunfish. There is little need to apply fertilizer unless the pond is to be fished intensively and the additional production removed from the pond.

More details of fish-pond management can be obtained from Farmers' Bulletin 1983, U. S. Department of Agriculture, entitled *Farm Fish Ponds.*

Fish for stocking the pond

Fish for farm ponds may be obtained from several sources. Application can be made to the U. S. Fish and Wildlife Service, U. S. Department of Interior, Washington 25, D. C. Both the number and variety of fingerlings received from this source are based on the information supplied on the application blank and approved by the New York State Conservation Department. There is no direct charge for fingerlings obtained through the Fish and Wildlife Service, but the pond owner must make application from six months to a year before delivery.

Private hatcheries can usually furnish fish on shorter notice; the price varies according to variety and size desired.

Fish produced by the New York State Conservation Department can be used to stock waters open to public fishing only and are not available to private pond owners.

[2]Reprint 152 from *New York State Conservationist,* August–September issue, 1953, Division of Conservation Education, Albany 1, New York, has helpful information on stocking ponds.